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(54) **RELATIONAL ADMINISTRATION OF SAS DOMAIN MANAGEMENT DATA**

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(52) **U.S. Cl.**
CPC ***G06F 13/14*** (2013.01)

(58) **Field of Classification Search**
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USPC 710/104, 313, 300, 305–306, 100; 711/114; 709/225–226
See application file for complete search history.

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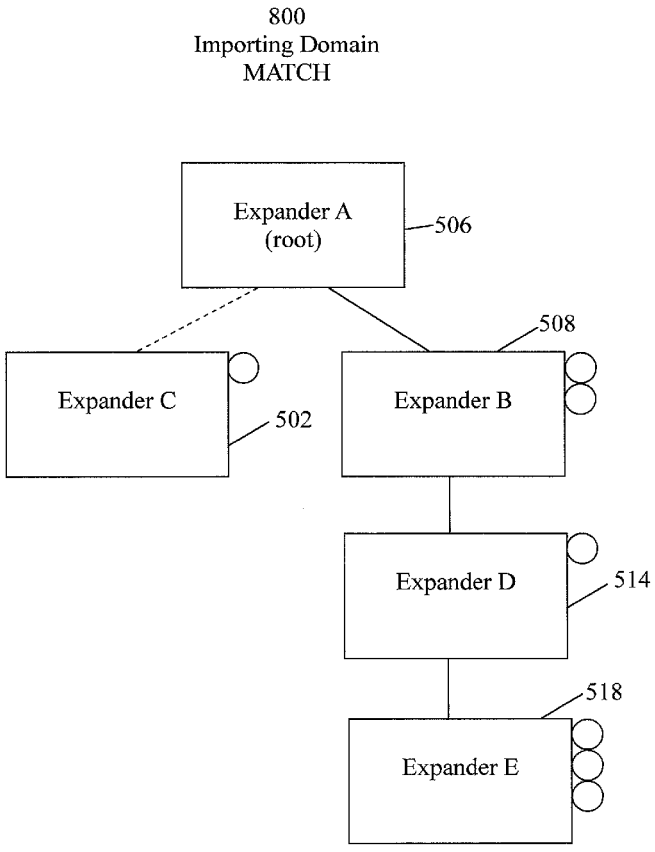
(57) **ABSTRACT**

Disclosed is a process that is performed by a management application for automatically mapping the topology of one domain to another domain. In addition, if a device in a domain fails, the domain application can automatically associate replacement devices with predecessor management objects.

20 Claims, 9 Drawing Sheets



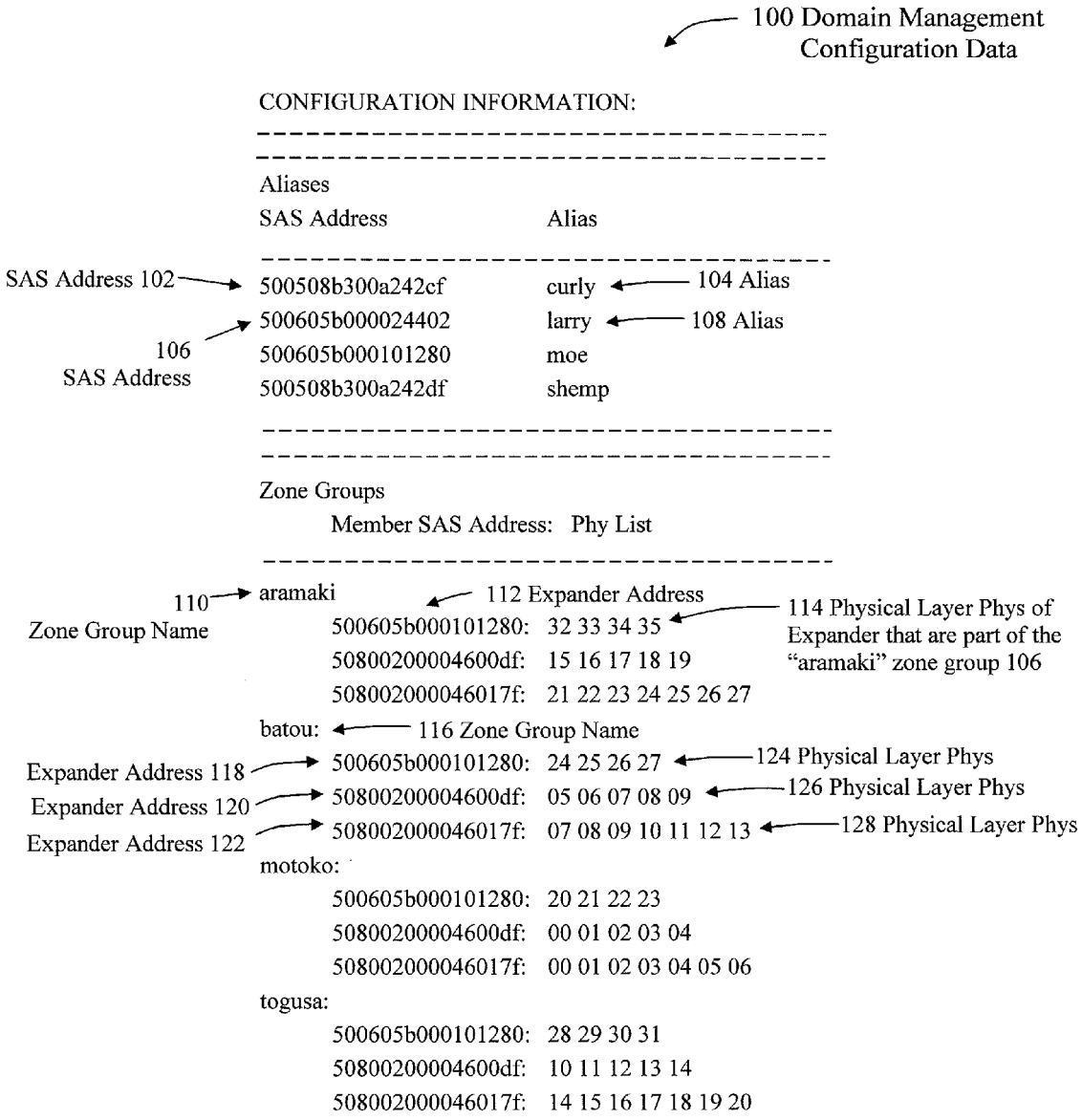

100 Domain Management Configuration Data
CONFIGURATION INFORMATION:
Aliases
SAS Address
Alias
SAS Address 102
500508b300a242cf
curly
104 Alias
500605b000024402
larry
108 Alias
106 SAS Address
500605b000101280
moe
500508b300a242df
shemp
Zone Groups
Member SAS Address: Phy List
110 Zone Group Name
aramaki
112 Expander Address
500605b000101280: 32 33 34 35
114 Physical Layer Phys of Expander that are part of the "aramaki" zone group 106
50800200004600df: 15 16 17 18 19
508002000046017f: 21 22 23 24 25 26 27
batou:
116 Zone Group Name
Expander Address 118
500605b000101280: 24 25 26 27
124 Physical Layer Phys
Expander Address 120
50800200004600df: 05 06 07 08 09
126 Physical Layer Phys
Expander Address 122
508002000046017f: 07 08 09 10 11 12 13
128 Physical Layer Phys
motoko:
500605b000101280: 20 21 22 23
50800200004600df: 00 01 02 03 04
508002000046017f: 00 01 02 03 04 05 06
togusa:
500605b000101280: 28 29 30 31
50800200004600df: 10 11 12 13 14
508002000046017f: 14 15 16 17 18 19 20

Fig. 1

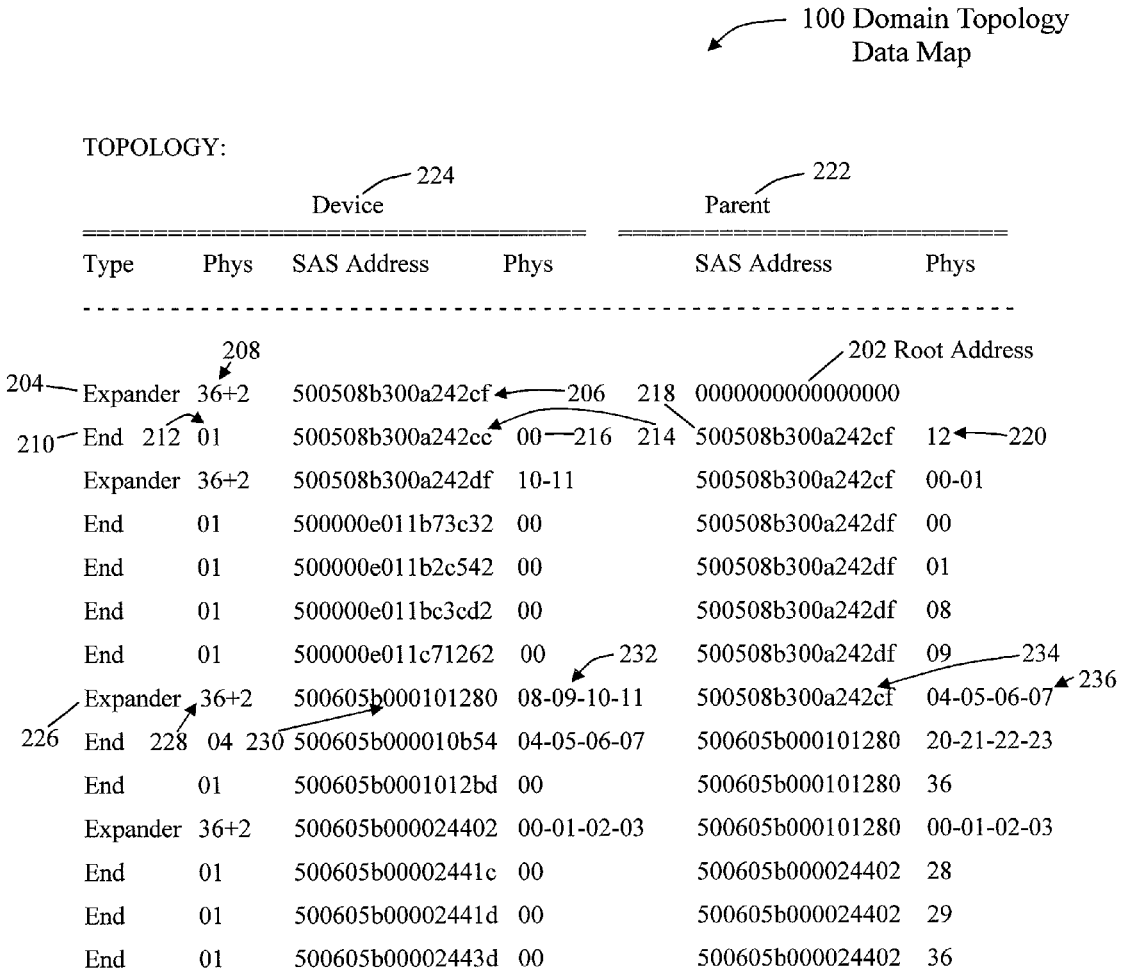

100 Domain Topology Data Map
TOPOLOGY:
224
Device
222
Parent
Type Phys SAS Address Phys SAS Address Phys
208
202 Root Address
204
Expander 36+2 500508b300a242cf 206 218 0000000000000000
210
End 212 01 500508b300a242cc 00 216 214 500508b300a242cf 12 220
Expander 36+2 500508b300a242df 10-11 500508b300a242cf 00-01
End 01 500000e011b73c32 00 500508b300a242df 00
End 01 500000e011b2c542 00 500508b300a242df 01
End 01 500000e011bc3cd2 00 500508b300a242df 08
End 01 500000e011c71262 00 232 500508b300a242df 09 234
236
Expander 36+2 500605b000101280 08-09-10-11 500508b300a242cf 04-05-06-07
226
End 228 04 230 500605b000010b54 04-05-06-07 500605b000101280 20-21-22-23
End 01 500605b0001012bd 00 500605b000101280 36
Expander 36+2 500605b000024402 00-01-02-03 500605b000101280 00-01-02-03
End 01 500605b00002441c 00 500605b000024402 28
End 01 500605b00002441d 00 500605b000024402 29
End 01 500605b00002443d 00 500605b000024402 36

Fig. 2

300 Domain Topology Data Map

TOPOLOGY:

		Device—304		Parent—302	
Type	Num Phys	SAS Address	Phys	SAS Address	Phys
Expander	36+2	5005083ca0012dcf		0000000000000000	
End	01	500508b300a21acc	00	5005083ca0012dcf	12
Expander	36+2	500508cc85639adf	10-11	50050803ca0012dcf	00-01
End	01	500000e011b787a2	00	500508cc85639adf	00
End	01	500000e011cac542	00	500508cc85639adf	01
End	01	500000e011b876d2	00	500508cc85639adf	08
End	01	500000e011c23462	00	500508cc85639adf	09
Expander	36+2	500605b0001ab180	08-09-10-11	5005083ca0012dcf	04-05-06-07
End	04	500605b000034a54	04-05-06-07	500605b0001ab180	20-21-22-23
End	01	500605b000164dbd	00	500605b0001ab180	36
Expander	36+2	500605b008283cb2	00-01-02-03	500605b0001ab180	00-01-02-03
End	01	500605b00008c36c	00	500605b008283cb2	28
End	01	500605b00004dcbd	00	500605b008283cb2	29
End	01	500605b00003a6cd	00	500605b008283cb2	36

306 310 312 308 314 316

Fig. 3

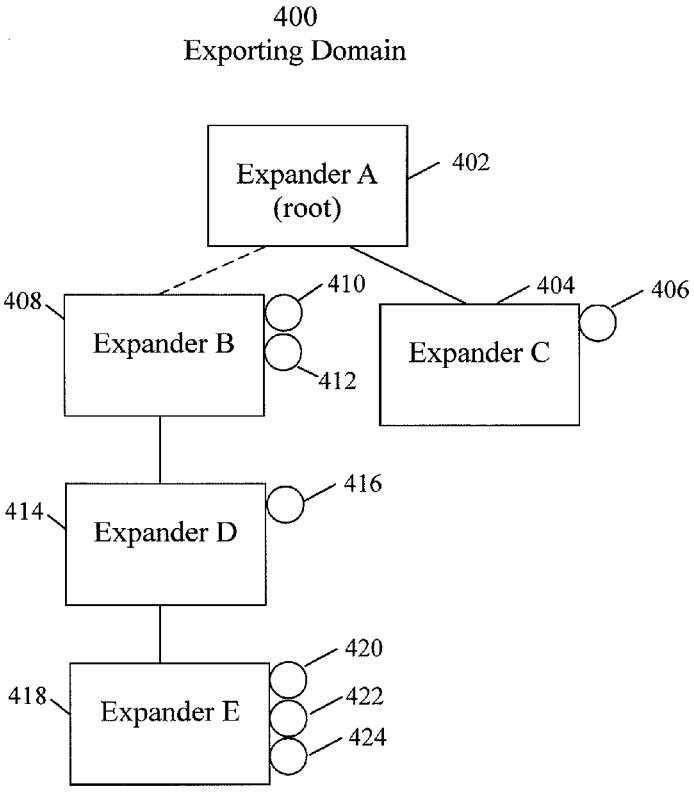

400
Exporting Domain
Expander A
(root)
402
408
Expander B
410
412
404
Expander C
406
414
Expander D
416
418
Expander E
420
422
424

Fig. 4

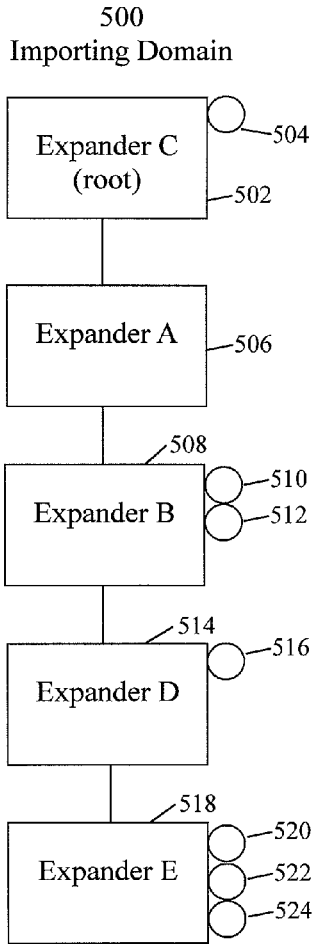

500
Importing Domain
Expander C
(root)
504
502
Expander A
506
508
Expander B
510
512
514
Expander D
516
518
Expander E
520
522
524

Fig. 5

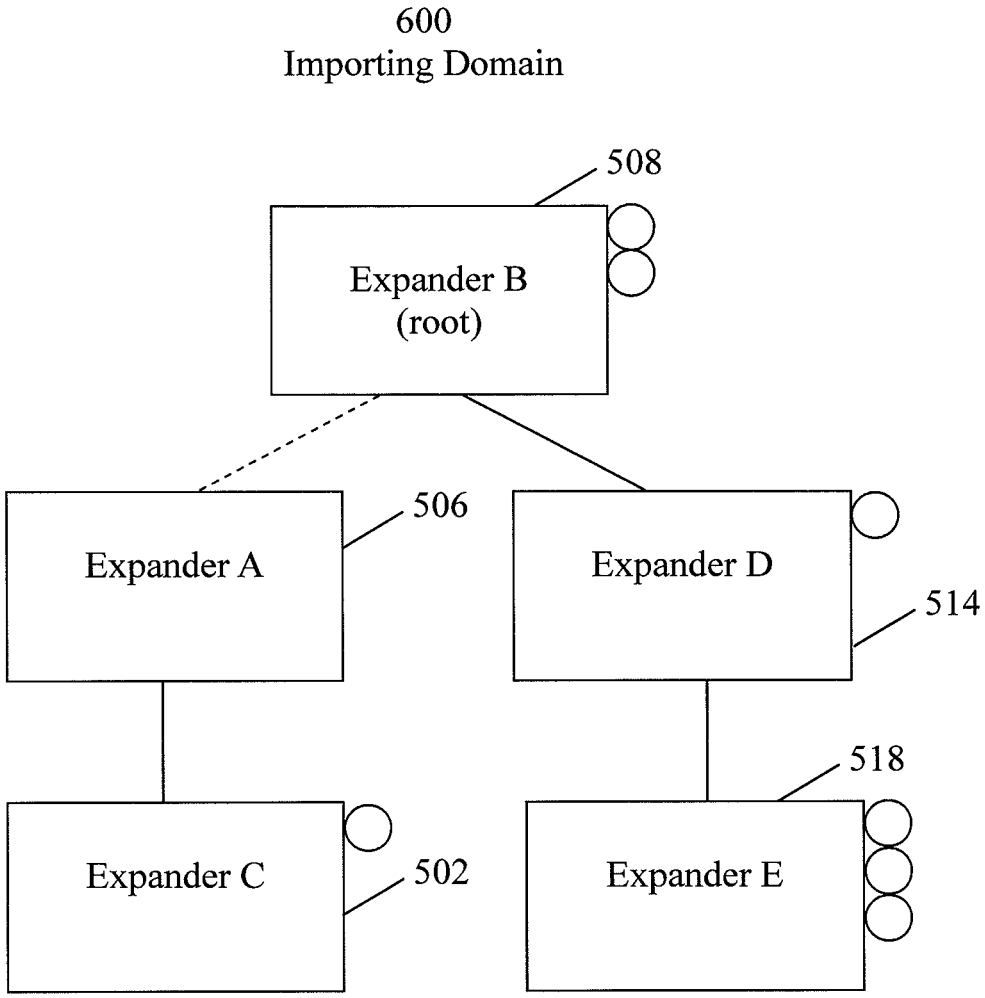

600
Importing Domain
508
Expander B
(root)
506
Expander A
Expander D
514
518
Expander C
502
Expander E

Fig. 6

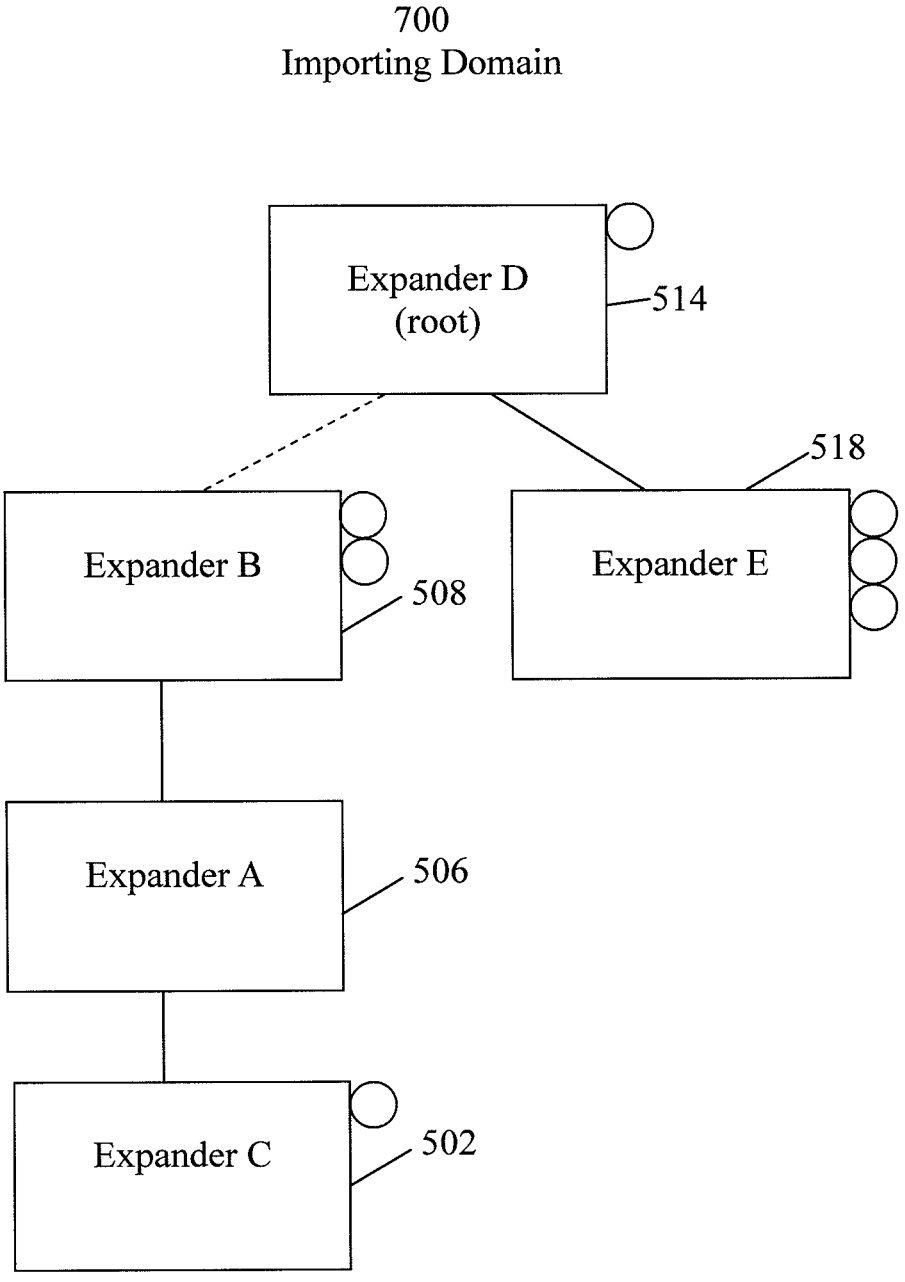

700
Importing Domain
Expander D
(root)
514
518
Expander B
508
Expander E
Expander A
506
Expander C
502

Fig. 7

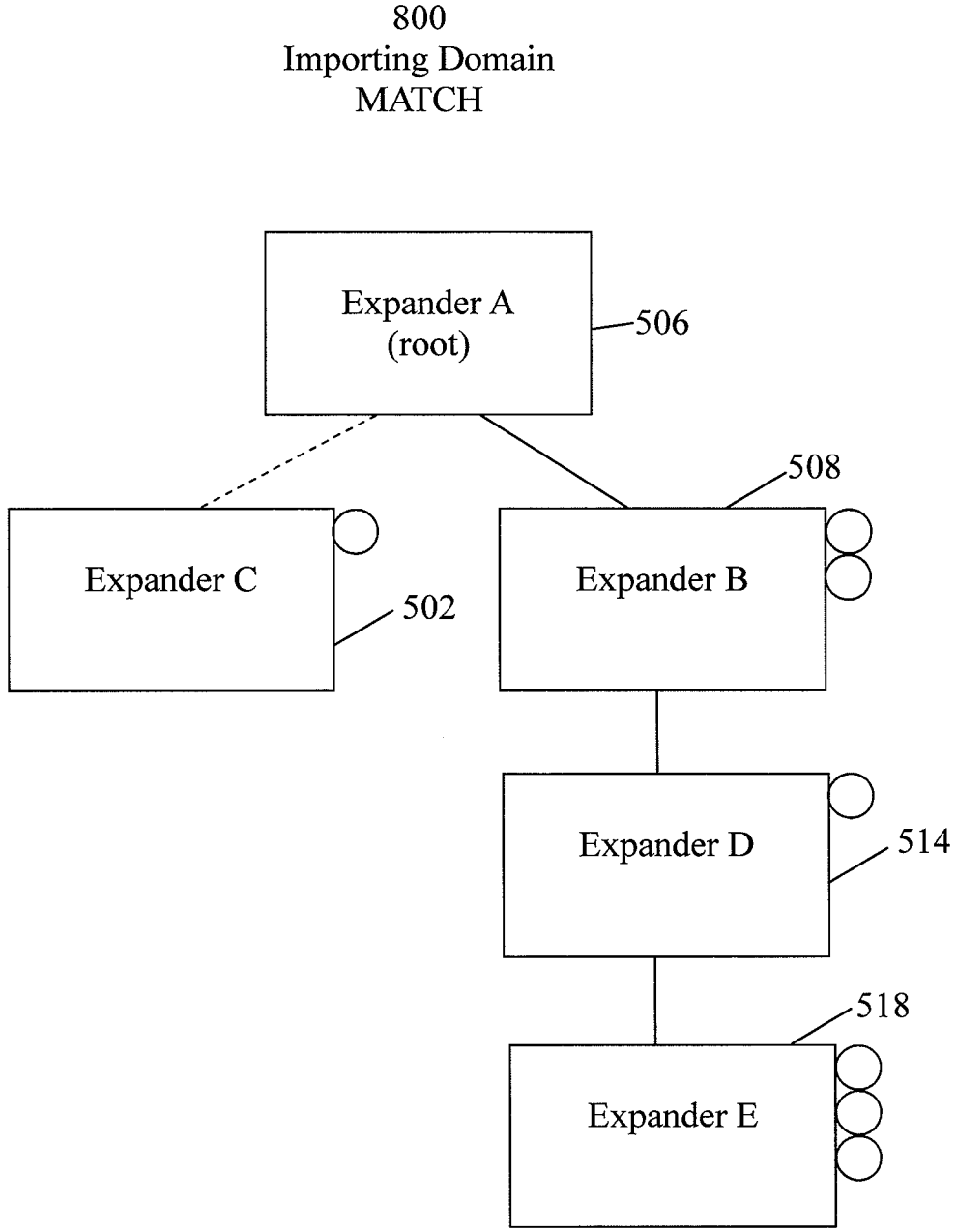

800
Importing Domain
MATCH
Expander A
(root)
506
508
Expander C
502
Expander B
Expander D
514
518
Expander E

Fig. 8

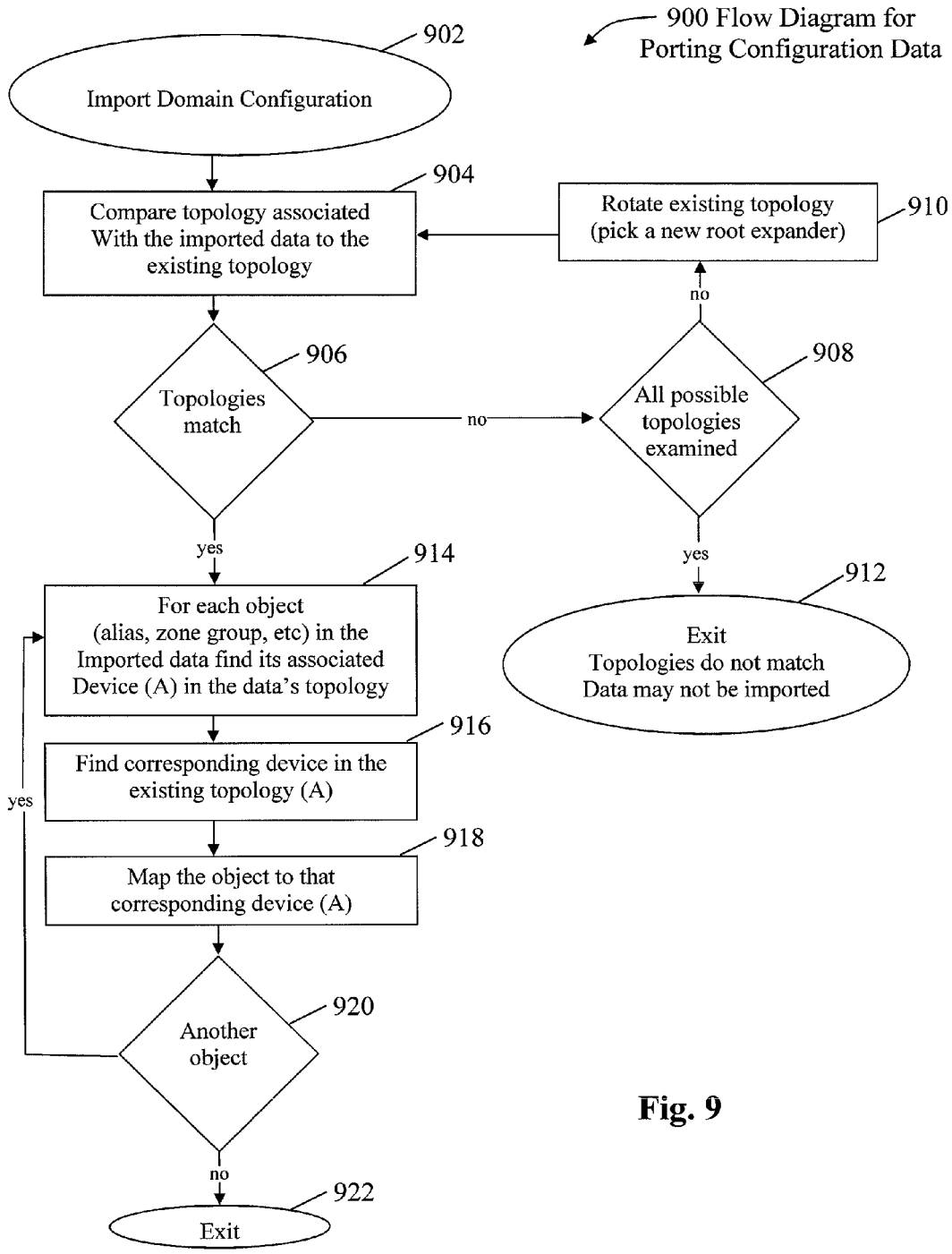

900 Flow Diagram for Porting Configuration Data
902
Import Domain Configuration
904
Compare topology associated With the imported data to the existing topology
906
Topologies match
no
908
All possible topologies examined
no
910
Rotate existing topology (pick a new root expander)
yes
912
Exit
Topologies do not match
Data may not be imported
yes
914
For each object (alias, zone group, etc) in the Imported data find its associated Device (A) in the data's topology
916
Find corresponding device in the existing topology (A)
918
Map the object to that corresponding device (A)
920
Another object
yes
no
922
Exit

Fig. 9

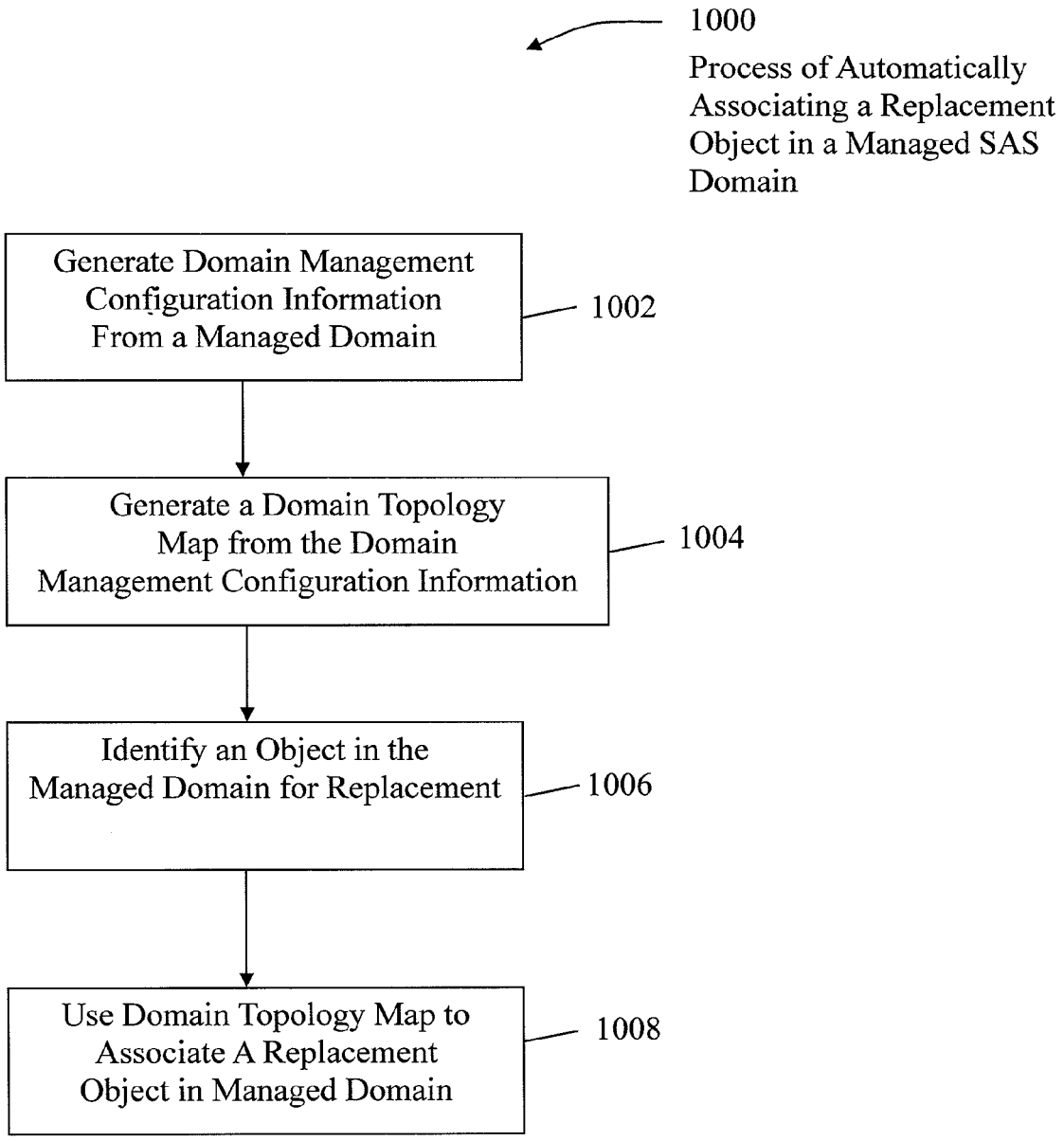

1000
Process of Automatically Associating a Replacement Object in a Managed SAS Domain
Generate Domain Management Configuration Information From a Managed Domain
1002
Generate a Domain Topology Map from the Domain Management Configuration Information
1004
Identify an Object in the Managed Domain for Replacement
1006
Use Domain Topology Map to Associate A Replacement Object in Managed Domain
1008

Fig. 10

RELATIONAL ADMINISTRATION OF SAS DOMAIN MANAGEMENT DATA

BACKGROUND

Serial attached SCSI (SAS) is a computer bus that is used to move data to and from computer storage devices, such as hard drives and tape drives. SAS depends on point to point serial protocol. Typical serial attached SCSI systems include an initiator, which is a device that originates service and requests for processing by a target device and receives responses for these requests from the target devices. An initiator may comprise a controller or host device. Targets are devices containing logical units and target ports that receive device service and task management requests for processing, and send responses for the same requests to initiator devices. Target devices may comprise a hard disk or disk array. Expanders are devices that facilitate communication between the SAS devices and facilitate the connection of multiple SAS end devices. A phy is a physical link that connects an SAS device to another SAS device. A port is a collection of one or more phys.

SUMMARY

An embodiment of the present invention may therefore comprise a method of porting domain configuration data from a first domain to a second domain comprising: creating a first domain topology map for the first domain having a first domain topology; creating a second domain topology map for a second domain having a second domain topology; comparing the first domain topology with the second domain topology; matching objects in the first domain topology map with corresponding objects in the second domain topology map whenever the first domain topology matches the second domain topology; mapping the configuration data from the objects in the first domain to objects in the second domain based on relationships formed on the basis of relative positions of the objects in the first domain topology map with the corresponding objects in the second domain topology map.

An embodiment of the present invention may further comprise a method of automatically associating a replacement object in a managed SAS domain comprising: generating domain management configuration information for a domain; generating a domain topology map from the domain management configuration information; identifying an object in the domain topology map for replacement; using data from the domain topology map to associate the replacement object in the domain.

An embodiment of the present invention may further comprise a method of porting domain configuration data from a first domain to a second domain comprising: creating a first domain topology map for the first domain having a first domain topology; creating a second domain topology map for a second domain having a second domain topology; comparing the first domain topology with the second domain topology; matching objects in the first domain topology map with corresponding objects in the second domain topology map whenever the first domain topology matches the second domain topology; mapping the configuration data from the objects in the first domain to the corresponding objects in the second domain based on relationships between the objects in the first domain and the corresponding objects in the second domain as determined by relative positions of the objects in the first domain topology map and corresponding objects in the second domain topology map.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is an illustration of domain management configuration information for a first managed domain.

FIG. **2** is an illustration of a domain topology map of the first managed domain that is generated from the domain management configuration information of FIG. **1**.

FIG. **3** is an illustration of a domain topology map of a second managed domain.

FIG. **4** is a schematic block diagram illustrating the topology of an embodiment of an exporting domain.

FIG. **5** is a schematic block diagram of one possible topology for an importing domain.

FIG. **6** illustrates another possible topology for an importing domain.

FIG. **7** illustrates another possible topology for an importing domain.

FIG. **8** illustrates another possible topology of an importing domain that matches the exporting domain.

FIG. **9** is a flow diagram for porting configuration data.

FIG. **10** is a flow diagram illustrating a process for automatically associating a replacement object in a managed SAS domain.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

FIG. **1** is an illustration of an example of domain management configuration information for an exporting domain that illustrates the use of aliases and zone groups. As shown in FIG. **1**, aliases can be associated with the SAS addresses of both end devices and expanders. For example, SAS address **102** has an alias **104** of "curly." SAS address **106** has an alias **108** of "larry." The aliases assist the user and the user interface in identifying the device, such as a particular target, initiator or expander.

FIG. **1** also illustrates four different zones, including aramaki, batou, motoko, and togusa. Under each zone group, the address of the expander is listed, together with the physical phy interconnectivity information. Domain management applications utilize this information to manage the SAS network. Zone groups control the accessibility of devices within a domain. For example, a domain may provide a high degree of connectivity between an initiator and a target. However, expanders may be programmed to only allow an initiator to access certain ports on the expander to thereby limit the accessibility of the initiator to a target. Zoning functions to limit the access of an initiator to only a specific set of targets, even though interconnectivity provided by the domain would otherwise allow access. In other words, a particular initiator may only have access to a subset of targets within a larger set of targets that are interconnected to an initiator through one or more expanders. The expanders are programmed to limit access of an initiator to a subset of physical phys on the expander, which limits the initiator's access to particular targets. A management application, through a user interface, establishes and maintains these zones.

As is apparent from FIG. **1**, the domain configuration is tightly bound to SAS addresses of devices present in the managed domain. As disclosed above, alias **104** (curly) is tied to SAS address **102**. Alias **108** (larry) is tied to SAS address **106**. Further, zone group **110**, which is called "aramaki," includes expander addresses **112** for three different expanders and physical layer phys **114** associated with the expander

addresses **112** within the zone group **110**. For example, zone group **116** (batou) has an expander address **118** and the associated physical layer phys **124**. Similarly, expander address **120** has the associated physical layer phys **126**. Expander address **122** has associated physical layer phys **128**. As such, the information for the zone group **116** is specifically tied to expander addresses and physical layer phys. Since the configuration information is tightly bound to the SAS addresses, porting the configuration information from one domain to another is difficult and has not been performed in an automated fashion. For example, the simple act of swapping a faulty device with a replacement within a management domain is cumbersome, requiring an administrator to redefine configuration definitions for the new domain.

Many SAS networks are configured to have redundant domains in which end devices, such as targets and initiators, are connected through two separate domains. The deployment of two different domains in this manner ensures continued operability in the event one domain becomes unstable or goes offline. In the redundant domain configuration, the redundant domains can be physically wired and configured to be identical to one another. Even so, the process of porting the configuration data from one domain to another is difficult because the porting configuration information is bound to the SAS addresses of the devices in that domain. In other words, each of the devices in a particular domain has no association with devices in other domains. As a result, an administrator managing two redundant domains, such as domain **1** and domain **2**, must manually configure aliases and zone groups for domain **1**, and then manually enter similar configurations for devices in domain **2**, to create a redundant or cloned SAS domain, for example, when domain one becomes inoperable. As indicated above, the administrator is forced to manually configure both domains, even though the configurations are identical, except for the SAS addresses. In accordance with embodiments of the present invention, a management application is able to automatically map configuration data onto the redundant copy of a domain, once the administrator has manually entered the domain configuration information of the domain. The process of requiring an administrator to manually enter configuration data for each domain is burdensome and problematic. In addition, because of the complexity of the process of configuring new domains, there may be a high probability of user error.

As another example, an administrator may wish to swap a device in a managed domain. If a device is swapped, an administrator is forced to reconfigure the aliases and zone groups that are bound to the SAS address of the failed device, with the SAS addresses of a new device. In accordance with embodiments of the present invention, the management application is able to automatically map configuration data associated with the old device to the replacement device.

Further, the view of a domain from a domain manager may differ from one domain to another, even though two domains are constructed in exactly the same configuration. For example, a domain manager for domain **1** may have a different access point and view of the devices within domain **1**, than a domain manager for domain **2**, even though domain **1** and domain **2** are identically wired, if access to domain **2** is from a different device. A domain management application may construct a view of domain **1** based from a particular root expander, such as a root expander that is deterministically discovered within the domain, such as a zoning expander with the highest SAS address. Since different SAS addresses are used in each domain, two domains that are physically identical may have root expanders positioned in different locations within the topology based upon the SAS addresses of the devices in each domain, which may determine the access point of the management application to the domain. As such, the topology of the two identically wired domains leads to a different view of each of the domains from the perspective of a domain manager that has a different access point.

FIG. **2** is an illustration of the domain topology map **200** that is derived from the domain management configuration data illustrated in FIG. **1**. As shown in FIG. **2**, the device column **224** lists each of the devices in the domain by type, the number of physical phys, the SAS address of each device, and the phy identifier of each device. The parent column **222** lists the SAS address of the parent devices for each of the devices listed in column **224** and the phy identifier of the parent, to which the device is connected. From the data shown in FIG. **2**, expander **204** has 36+2 (36 physical phys, 2 virtual phys) physical ports **208** and has an SAS address **206**. The SAS address of the parent of expander **204** is address **202**, which is the root address for the domain, as indicated by all zeros in SAS address **202**. End device **210** has one physical port **212** and has an SAS address **214**. The physical port for end device **210** is shown as physical port **216**. The SAS address **218** of end device **210** is the SAS address of expander **204**, indicating that end device **210** is connected to expander **204**. Physical address **220** is the physical address of the port of the parent device, which is expander **204**, to which end device **210** is connected. As such, end device **210** is connected to phy **12** of expander **204**. The remaining domain topology data is listed in FIG. **2**, which provides all of the interconnections of each of the devices in the domain, including the SAS addresses of the devices and the physical phys. In this manner, all of the domain topology of the data sample **100** is provided in the domain topology map **200**, illustrated in FIG. **2**. Utilizing the domain topology map **200**, illustrated in FIG. **2**, the configuration data of one domain can be automatically ported to a redundant domain, so it may be utilized if the first domain becomes inoperable. Further, replacement of devices within a domain having new SAS addresses can be automatically configured into an existing domain if a device becomes inoperable.

The process of allowing a SAS domain management application to import and/or restore configuration information, including aliases, zone groups, etc. is performed in a relational manner. As such, the domain topology map, such as the domain topology map illustrated in FIG. **2**, is obtained for each domain. The relationships defined in the domain topology map are then used to import the domain topology configuration data from an existing managed domain (exported domain) to a new domain (imported domain). Alternatively, the relationships defined in the domain topology data map **200** can be used to automatically restore configuration information once a new device has been inserted into a managed domain, as a replacement for a failing unit. The domain topology data map **200** of FIG. **2** provides the relational data for porting a domain topology to another topology. Hence, the mapping of topologies is not a direct mapping of objects, but rather, a mapping of relationships between the objects, to ensure that the exporting topology can be ported to the importing topology and new SAS addresses can be assigned. The relationships are based upon relative positions of the objects in topology maps.

FIG. **3** is a domain topology data map **300** that illustrates the domain topology of a redundant domain of the domain illustrated in FIGS. **1** and **2**. As shown in FIG. **3**, the domain topology data map **300** lists the devices **304** and parent devices **302**. The type of device, the number of physical phys, the SAS addresses, the phy identifiers, the SAS addresses of the parent, and the phy identifiers of the parent, are all listed

for the redundant domain, in the same manner as they are listed in FIG. **2**. As illustrated in FIG. **3**, the eighth device down in the domain topology list is an expander **306**, which has the number of physical phys **310**, illustrated as 36+2, a SAS address **308**, and phy identifiers **312**. The parent device associated with expander **306** is located at address **314** and has phys **316** activated. Referring to FIG. **2**, it can be seen that expander **226** is the eighth device in the domain topology data map **200**. In addition, expander **226** has the number of physical phys **228** equal to 36+2, an SAS address of **230**, and phy identifiers **232**. In addition, the parent device of expander **226** has an SAS address **234** and phy identifiers **236**. A comparison shows that the number of phys **228** of expander **226** is equal to the number of phys **310** of expander **306**. Further, the actuated port numbers **232** of expander **226** are the same as the phy identifiers **312** of expander **306**. Further, the parent device of expander **226** has phy identifiers **236**, which match the phy identifiers **316** of the parent device of expander **306**. Hence, the only information that differs between expander **226** and expander **306** is the SAS address **308** of expander **306**, which does not match the SAS address **230** of expander **226**. Further, the SAS address **234** of expander **226** is different from the SAS address **314** of expander **306**. However, the activated phy identifiers **236** of expander **226** match the phy identifiers **316** of expander **306**. Hence, there is a match, except for the SAS addresses of the device and the parent device. A comparison of the other devices in FIG. **2** with the devices listed in FIG. **3** illustrates the manner in which the domain topology **200** can be ported to the domain topology **300** and provide new SAS addresses.

In addition, if expander **226** of FIG. **2** fails, expander **226** can be replaced with a new expander having a new address, and the new expander can be configured to have the same number of phys **228**, the same phys **232**, and connections to the parent at address **234**.

In order to successfully import configuration information, the overall domain topology of the importing domain must match the existing topology of the existing domain. For example, the following conditions must be met: 1) the set consisting of the devices of the importing topology must match, or be a super-set of, the devices in the existing topology. In other words, there must be the same number of devices in the importing domain as the exporting domain, or there must be fewer devices in the exporting domain than the importing domain. That is, the number of devices in FIG. **3** must match the number of devices in FIG. **2**, or the devices in FIG. **2** must be less than the number of devices in FIG. **3**; 2) the relationships between the set of devices and the importing topology must match the relationship in the existing topology. This means that the relationship between the expanders and the end devices must be same to map the topology from one domain to another; 3) the physical phys used to connect the set of devices in the importing topology must match the physical phys in the existing topology. For example, the physical phys **312**, **316** must match the physical phys **232**, **236**, respectively.

As indicated above, even though the two domains are identically wired, the domain topologies of two identically wired domains may appear to be different, based upon the management application's view of the domain. As also described above, an algorithm may be used by the management routine to deterministically identify a root expander that is different than the root expander in the exporting domain, which results in a topology that has a different shape and appears to be different from the exporting domain topology. For example, an exporting domain **400** may have a topology, such as illustrated in FIG. **4**. The root expander **402** is expander A in the exporting domain **400**. Attached to expander **402** is expander C **404**, having an end device **406** and expander B **408**, having end devices **410**, **412**. Expander C **404** is not connected to any other expanders. Expander B **408** is connected to expander D **414**. Expander D **414** has one end device **416**. Expander D is connected to expander E **418**, having end devices **420**, **422**, **424**. As illustrated in FIG. **5**, the importing domain has expander C **502** as the root expander. Expander C has one end device **504**. As shown in FIG. **4**, expander C **404** has one end device **406** and is connected to expander A **402**, which is the root expander. As illustrated in FIG. **5**, expander C **502** is connected to expander A **506**, which is the same structure as shown in exporting domain **400**, of FIG. **4**. Expander A **506** does not have any end devices to which expander A **506** is connected, which is the same as expander A **402** of FIG. **4**. Expander A **506** of FIG. **5** is connected to expander B **508**, having two end devices **510**, **512**. Expander B **508** is connected to expander D **514**, having one end device **516**. Expander D **514** is connected to expander E **518**, having three end devices **520**, **522**, **524**. A comparison of FIGS. **4** and **5** illustrates that expander B **508** is connected to expander A **506** and expander D **514**. Similarly, expander B **408** is connected to expander A **402** and expander D **414**. Further, expander B **508** has two end devices **510**, **512**, while expander B **408** has two end devices **410**, **412**. Similarly, expander D **514** is connected to expander B **508** and expander E **518**. Expander D **514** has one end device **516**. As illustrated in FIG. **4**, expander D **414** is connected to expander B **408** and expander E **418**. Expander D **414** also has one end device **416**. Hence, the structure and connections of expander D **514** match the connections and structure of expander D **414**. Expander E **518** is connected to expander D **514**. Expander E **518** has three end devices **520**, **522**, **524**. As shown in FIG. **4**, expander E **418** is connected to expander D and has four end devices **420**, **422**, **424**. Hence, expander E **518** matches the connections and structure of expander E **418**. The difference between the importing domain **500** of FIG. **5** and the exporting domain **400** of FIG. **4** is simply the expander that has been selected as a root expander. The expander A **402** of exporting domain **400** of FIG. **4** is the root expander. Expander C **502** of importing domain **500** is the root expander of the importing domain **500** of FIG. **5**. If expander A **506** of importing domain **500** were made to be the root expander, importing domain **500** would have the same topology as exporting domain **400**.

The process of determining whether an importing domain, such as importing domain **500**, has the same topological structure as an exporting domain, such as exporting domain **400**, each of the expanders in the importing domain can be selected as a root expander and then the topologies can be compared to determine if the topologies map. For example, the importing domain **600** of FIG. **6** selects the expander B **508** as the root expander. Expander A **506** is connected to expander B **508** and to expander C **502**. Similarly, expander B **508** is connected to expander D **514**, which, in turn, is connected to expander E **518**. Comparing importing domain **600** of FIG. **6** with exporting domain **400** of FIG. **4**, there is no match between the topologies.

FIG. **7** is another illustration of an importing domain **700**. As shown in FIG. **7**, expander D **514** is selected as the root expander. Root expander D **514** is connected to expander E **518** and expander B **508**. Expander B **508** is connected to expander A **506**. Expander A **506** is connected to expander C **502**. Using expander D **514** as the root expander, there is no match between the importing domain **700** of FIG. **7** and the importing domain **400** of FIG. **4**.

FIG. **8** illustrates another importing domain **800**, which utilizes expander A **506** as the root expander. Root expander

A **506** is connected to expander C **502** and expander B **508**. Expander B **508** is connected to expander D **514** and expander E **518**. A comparison of importing domain **800** of FIG. **8** with exporting domain **400** of FIG. **4** indicates that there is a match between the topologies of these two domains. Since there is a match of topologies, the process of porting topology information can be performed. In this manner, by rotating the root expander, to each of the expanders, the process of determining if there is a match between topologies can be performed.

FIG. **9** is a flow diagram of one embodiment for porting configuration data. As illustrated in FIG. **9**, the domain configuration of a first domain (an export domain) is imported by the management application at step **902**. At step **904**, the management application compares the topology of a second domain with the imported domain configuration of the second domain. At step **906**, if the topologies do not match, the process proceeds to step **908**. At step **908**, it is determined whether all the different possibilities of topologies have been examined. If they have, the process proceeds to step **912** and it is determined that the topologies do not match and may not be imported. If all possible topologies have not been examined at step **908**, the process proceeds to step **910**. At step **910**, the topology of the second domain is rotated, so that a new root expander is designated. The process then proceeds to step **904** to compare the topology of domain **1** with the topology of domain **2**. The process then proceeds to step **906** to then determine if the newly rotated topology of the second domain matches the first domain. This loop proceeds until a match is determined, or to determine if there is no match. If a match is determined, the process proceeds to step **914**. At step **914**, each device, including aliases and zone groups of the first domain are compared to find the associated devices, including aliases and zone groups in the second domain. The process then proceeds to step **916**, where the corresponding device in the second domain is determined. At step **918**, the object in the first domain is mapped to the corresponding device in the second domain. At step **920**, it is determined whether there is another object in the first domain that needs to be mapped to the second domain. If there is, the process returns to step **914** to locate that object. If there are no other objects, the process proceeds to step **922** to exit.

FIG. **10** is a flow diagram illustrating a process **1000** for automatically associating a replacement object in a managed SAS domain. As shown in FIG. **10**, at step **1002**, domain management configuration information is generated for a managed domain. At step **1004**, a domain topology map is generated from the domain management configuration for the managed domain. At step **1006**, an object is identified in the managed domain for replacement. At step **1008**, the domain topology map is used to associate a replacement object in the managed domain in an automated fashion in the management application.

Hence, the SAS domain management application is capable of decoupling the SAS address relationships, which bind the objects to a managed domain and allow the management application to map the topology of a first domain to a second domain. The process performed by the SAS domain management application in mapping topology information from one domain to another frees the administrator from the task of manually duplicating similar objects in multiple, but similar, managed domains. Further, this process cannot only be used to map one domain to another, but also may be used to automatically associate replacement devices with predecessor management objects.

The foregoing description of the invention has been presented for purposes of illustration and description. It is not intended to be exhaustive or to limit the invention to the precise form disclosed, and other modifications and variations may be possible in light of the above teachings. The embodiment was chosen and described in order to best explain the principles of the invention and its practical application to thereby enable others skilled in the art to best utilize the invention in various embodiments and various modifications as are suited to the particular use contemplated. It is intended that the appended claims be construed to include other alternative embodiments of the invention except insofar as limited by the prior art.

What is claimed is:

1. A method of porting SAS domain configuration data in an SAS network from a first SAS domain to a second SAS domain comprising:

creating a first SAS domain topology map for said first SAS domain having a first SAS domain topology that lists first devices in said first SAS domain, SAS addresses of said first devices, and SAS addresses of first parent devices of said first devices and physical interconnections between said first devices and said first parent devices;

creating a second SAS domain topology map for a second SAS domain having a second SAS domain topology that lists second devices in said second SAS domain, SAS addresses of said second devices, and SAS addresses of second parent devices of said second devices and physical interconnections between said first devices and said first parent devices;

comparing said first SAS domain topology map with said second SAS domain topology map;

matching said first devices and relational interconnections of said first devices with said first parent devices in said first SAS domain topology map with said second devices and relational interconnections of said second devices with said second parent devices in said second SAS domain topology map to identify correspondence between said first devices and relational interconnections of said first devices with said first parent devices in said first SAS domain topology map and said second devices and said relational interconnections of said second devices with said second parent devices in said second SAS domain topology;

if said first SAS domain topology map does match said second SAS domain topology map, mapping said SAS domain configuration data from said first domain topology map to said second domain topology map based on said relational interconnections that provide relative positions of said first devices and first parent devices in said first domain topology map with corresponding second devices and second parent devices in said second domain topology map.

2. The method of claim **1** further comprising:

sequentially selecting expanders in said second SAS domain as root expanders to obtain a series of additional topologies for said second SAS domain whenever said first domain topology map does not match said second domain topology map;

comparing said series of additional topologies for said second SAS domain with said first SAS domain topology to obtain a second SAS domain topology from said series of additional topologies that matches said first SAS domain topology.

3. A method of automatically associating a replacement device in a managed SAS domain, the method comprising:

generating domain management configuration information for a SAS domain using physical addresses and SAS addresses;

generating a domain topology map based on the domain management configuration information, wherein the domain topology map indicates relative positions of SAS devices on the SAS domain with respect to other SAS devices on the domain;

identifying a device in the domain topology map for replacement;

using the physical addresses and the SAS addresses of the device to import the replacement device into the SAS domain, by matching configuration information between the device and the replacement device, based on the relative positions of SAS devices on the SAS domain indicated by the topology map.

4. A method of porting domain configuration data from a first domain to a second domain comprising:

creating a first SAS domain topology map for said first SAS domain having a first SAS domain topology that lists first devices in said first SAS domain, SAS addresses of said first devices, and SAS addresses of first parent devices of said first devices;

creating a second SAS domain topology map for a second SAS domain having a second SAS domain topology that lists second devices in said second SAS domain, SAS addresses of said second devices, and SAS addresses of second parent devices of said second devices;

comparing said first SAS domain topology map with said second SAS domain topology map;

matching said first devices and relational interconnections of said first devices with said first parent devices in said first SAS domain topology map with said second devices and relational interconnections of said second devices with said second parent devices in said second SAS domain topology map to identify correspondence between said first devices and relational interconnections of said first devices with said first parent devices in said first SAS domain topology map and said second devices with said second parent devices in said second SAS domain topology;

if said first SAS domain topology map does match said second SAS domain topology map, mapping said SAS domain configuration data from said first devices in said first domain topology map to corresponding second devices in said second domain topology map based on physical connections between said first devices in said first SAS domain and said corresponding second devices in said second SAS domain as determined by relative positions of said first device in said first SAS domain topology map and corresponding second devices in said second SAS domain topology map.

5. The method of claim **4** further comprising:

sequentially selecting expanders in said second SAS domain topology map as root expanders to obtain a series of additional SAS topologies for said second SAS domain whenever said first SAS domain topology map does not match said second SAS domain topology map;

comparing said series of additional SAS topologies for said second SAS domain with said first SAS domain topology map to obtain a second SAS domain topology map from said series of additional topologies that matches said first SAS domain topology map.

6. The method of claim **1**, wherein:

comparing the first SAS domain topology map with the second SAS domain topology map comprises selecting an expander as a root expander of the second SAS domain.

7. The method of claim **6**, wherein:

selecting an expander as a root expander comprises selecting an expander of the second SAS domain having a highest SAS address.

8. The method of claim **1**, wherein:

a match does not exist between the first SAS domain topology map and the second SAS domain topology map unless:

there are the same number of devices in the second SAS domain as the first SAS domain, or

there are fewer devices in the first SAS domain than the second SAS domain.

9. The method of claim **1**, further comprising:

assigning new SAS addresses to the first devices or the second devices.

10. The method of claim **1**, wherein:

the first SAS domain topology map lists the same types of information as the second SAS domain topology map.

11. The method of claim **1**, further comprising:

comparing aliases and zone groups of the first SAS domain topology map with aliases and zone groups of the second SAS domain topology map.

12. The method of claim **1**, wherein:

the first SAS domain topology map additionally lists a number of physical PHYs for each of the first devices, and PHY identifiers for each of the first devices.

13. The method of claim **1**, further comprising:

comparing PHY identifiers of the first parent devices with PHY identifiers of the second parent devices.

14. The method of claim **4**, wherein:

comparing the first SAS domain topology map with the second SAS domain topology map comprises selecting an expander as a root expander of the second SAS domain.

15. The method of claim **14**, wherein:

selecting an expander as a root expander comprises selecting an expander of the second SAS domain having a highest SAS address.

16. The method of claim **4**, wherein:

a match does not exist between the first SAS domain topology map and the second SAS domain topology map unless:

there are the same number of devices in the second SAS domain as the first SAS domain, or

there are fewer devices in the first SAS domain than the second SAS domain.

17. The method of claim **4**, further comprising:

assigning new SAS addresses to the first devices or the second devices.

18. The method of claim **4**, wherein:

the first SAS domain topology map lists the same categories of information as the second SAS domain topology map.

19. The method of claim **4**, further comprising:

comparing aliases and zone groups of the first SAS domain topology map with aliases and zone groups of the second SAS domain topology map.

20. The method of claim **4**, wherein:

the first SAS domain topology map additionally lists a number of physical PHYs for each of the first devices, and PHY identifiers for each of the first devices.

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